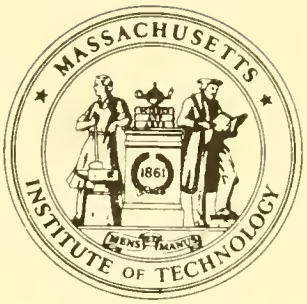

WORKING PAPER
ALFRED P. SLOAN SCHOOL OF MANAGEMENT

Appendix to Task III: The Financial Determinants of the Demand for Housing

James Kearl
Kenneth Rosen
Craig Swan

Working Paper Number 796-75

July 1975

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This technical report essentially provides an appendix to our paper published in Conference Series #14, Federal Reserve Bank of Boston, 1975.

We were concerned not just with the materials summarized in that survey but with the implications that a particular structure of econometric modeling had for the variety of results that everyone encounters when examining several pieces of econometric work. Research that is nominally, at least, about the same business.

Hence, we spent some time analyzing the structures of various econometric models, and are providing here both descriptive and schematic comparisons of that work.

Section I provides schematics for overall comparison of model structure and included/excluded variables. The models are reported as estimated. Those empirical studies examining starts (quantity) are outlined in Chart I. Those examining value of start are in Chart II. Research examining mortgage demand functions, most normalized on the mortgage rate, are in Chart III.

Section II is an annotated bibliography of most of the econometric work done in the aggregate housing area. It does not include research on urban or local housing but is limited to macro-econometric studies.

We suggest that the reader use our survey paper as a source of some analysis and our views of the quality and importance of the work included here.

CHART I: NUMBER OF STARTS

	DEP. VARIABLE	INCOME	P_{HOUSE}	P_{OTHER}	RENTAL	COSTS	$r_{MORTGAGE}$	r_{OTHER}	LOAN / VALUE	AMORTIZATION PERIOD	MORTGAGE	SAVINGS	STOCK	DEP. VARIABLE$_{-1}$	FHLB	FNMA	DEMOGRAPHIC	VACANCY	OTHER
ARCELUS - MELTZER	C^u	Y_n^E		P	R														B/P S/P
	$^pH'$		PH		R			$r_{\cdot}$			MS/P								$\hat{C}^u$ B/P S/P
	^sH		PH		R			r_{mm}											L
DRI	H · MOB						$(r_m^c - \dot{P}I^c) \cdot POP1$				$\Delta OC/PI$	$\sum_4 \Delta MS/PI_{-i}$						$(\frac{1}{4}\sum VAC_{-i}) \cdot POP3$	
FAIR	^pH						r_{m-2} Δr_m						$\sum^5 H_i$					TW	DUM1
	^sH						r_{m-1} Δr_m					$\frac{1}{3}\sum SAV_{-}$			$\frac{1}{4}\sum FHLB_{-i}$			TW	DUM1
HUANG	$^pH'^m$						r_m^{fmm}		ΔLVR^p $\Delta AMORT^p$					H_{-1}^p			ΔHHF_{-1}		
	$^pH^m$		ΔPV						$\Delta (LVR/AMORT)^m$					H_{-1}^m			ΔHHF_{-1}		
	$^pH^c$	ΔY^p				C/			ΔLVR^c $\Delta AMORT^c$		$\Delta (MS/A)$			H_{-1}^c					
	$^sH'^m$					C/PV	$(r_m^{fmm} - r_m)$	r_{co-1}						H_{-1}^m	H_{-2}^m				
	$^sH^m$						$(r_m^m - r_m)$	r_{co-1}						H_{-1}^m	H_{-2}^m	FNMA			
	$^sH^c$					C/PV		r_{co-1}				SAV_{-1}		H_{-1}	H_{-2}	FHLB			
KEARL-ROSEN	^pH	Y_n^p	$(PH/P)_{-1}$				r_m		LVR$_{-1}$								HHF		T SUB
	^sH					$(PH/C)_{-1}$		r_{mm}			M							VAC	
MAISEL	H				$(R/C)_{-1}$			$\frac{1}{3}\sum r_{co-i}$						H_{-1} H_{-3}			ΔHHF	VAC	DEP
	H	Y_{-1}^p			$\frac{1}{4}\sum R/PH_{-i}$		$\frac{1}{4}\sum r_{m-i}$							H_{-1} H_{-3}		$\frac{1}{3}\sum FNMA_{-i}$		$\frac{1}{4}\sum VAC_{-i}$	
	H	Y_{-1}^p			$\frac{1}{4}\sum R/PH_{-i}$		$\frac{1}{3}\sum r_{m-i}$					$\frac{1}{3}\sum SAV_{-i}$		H_{-1} H_{-3}				VAC$_{-1}$	
SPARKS	ΔH	ΔY			$\Delta (R/C)_{-1}$						$\Delta (M+OC)$			$(H_{-1} - HHF_{-1})$		$\Delta FNMA$	ΔHHF		

CHART IA: NUMBER OF STARTS

	DEP. VARIABLE	$r_{MORTGAGE}$	r_{OTHER}	SAVINGS	DEP. VARIABLE$_{-1}$	FHLB	VACANCY	OTHER
JUITS	ΔH	$\Delta[\gamma_1(r_m^{(m)} + r_m^{(m)}) - r_{mm}]$			H_{-1}			
SWAN	H	r_{m-1}		SAV	H_{-1}	FHLB		T
	^{a}H	r_{m-1}	Δr_m				VAC$_{-1}$	T
	^{b}H	r_{m-1}	Δr_m	SAV$_{-1}$		FHLB$_{-1}$		

	DEP. VARIABLE	INCOME	P_{HOUSE}	P_{OTHER}	RENTAL COSTS	$r_{MORTGAGE}$	r_{OTHER}	LOAN / VALUE	AMORTIZATION PERIOD	MORTGAGE STOCK	DEP. VARIABLE$_{-1}$	FHLB ADVANCES	FNMA	DEMOGRAPHIC	VACANCY	OTHER
BOSWORTH DUETENBERRY	HV					$\Delta(r_m^c - r_{mm})_{-1}$				$\Delta(MS/PI)\,\Delta(MS/PI)_{-1}$				ΔHHF		T DUM71
BRADY	HV^c					r_m^c	$(r_m^c - r_{mm})$		AMORT		HV^{va} HV^{rm}					STRG
	HV^{rm}				R/P		$(r_m^{rm} - r_{mm})$	LVR		$OCLI_{-2}$	HV^c HV^{va}		FNMA			
	HV^{va}					r_m^{va}	$(r_m^{va} - r_{mm})$			$OCLI_{-2}$	HV^c HV^{rm}		FNMA			
	HV				C	r_m^c		LVR				FHLB				T
MPS	$\Delta(HVI/POPS \cdot C)$	$\Delta(Y_c^p/POP)$		$\sum_i b_i \ln(P/C \cdot RC1)_{-i}$ $RC1 = (1-TX)(.7\,r_m + .3\,r_{mm} + .8\,TP) - 1.46$						$\sum_i a_i \ln(1 - (\frac{OCSL + FNMA}{OCSL^* + FNMA^*})_{-i}$	$\ln(HSI/POP2)_{-1}$					T $\sum_i a_i \ln UL_{-i}$
	$\Delta(HVM/POP3 \cdot C)$	$\Delta(Y_c^p/POP)$		$\sum_i b_i \ln(P/C)_{-i}$						$\sum_i a_i \ln(\frac{OCSL}{OCSL^*})_{-i} + a_i \ln OCLI_{-i}$	$\ln(HSM/POP3)_{-1}$					DUM66
LEE	$HVS/PH \cdot POPS$	$Y_c^p/POPS$			C	$(r_m - AMORT)$		LVR		$(HS/POPS)_{-1}$						
LIU	HVI/P					$\frac{1}{3}\sum r_{mm-i}$				$(HS/POP)_{-1}$, $(HVO/POP)_{-1}$, $(HVO/POP)_{-2}$						T $\sum$ M2$_{-i}$
REID	HV/POP	Y_c^p/POP			$(C/P)_{-1}$											
WHARTON	HV	Y^D	$\sum_i a_i (PI/R)_{-i}$			$\sum_i b_i (r_{mm} - r_{cd})_{-i}$										
	HV	Y^D	$(PI/R)_{-3}$			$(r_{mm} - r_{cd})_{-3}$										
CASSIDY VALENTINI	^{D}HV1 $(\frac{1}{3})_{-1} Y^D/HH - a_1 \ln POPS - a_2 \ln RCI_{-1}$										HSI_{-1}					DQ3 DQ1 DQ2
	^{R}HVM $a_1 \ln POPS - a_2 \ln RCM_{-1} - a_3 \ln RCM_{-3}$										HSM_{-1}					DQ3 DQ1 DQ2
	$\ln(PH/WPI)$										$\ln HVI$				$\ln U$ $\ln W/WPI$	DQ3 DQ1 DQ2

CHART III: MORTGAGE DEMAND

	DEP. VARIABLE	$r_{MORTGAGE}$	r_{OTHER}	DEPOSITS	MORTGAGE STOCK	HOUSING STOCK	HOUSING STARTS	LOAN / VALUE	AMORTIZATION PERIOD	INCOME	RENTAL P HOUSING	VACANCY	DEMOGRAPHIC	COMMITMENTS
BOSWORTH-DUESENBERRY	Δr_m	r_{m-1}	$r_{v1}^{1-5\,YR}$	$\%\Delta SAVN$	$\%\Delta MS$	$\%\Delta MS_{-1}$						VAC_{-1}		$SAVN = .75\,DSL + .25\,DST + .03\,DCB + .05RL$
CLAURETIE	M	r_m						LVR	AMORT	Y^P	R/PH		DEM	
DRI	r_m		r_{n1} r_{m-1} r_{m-2}		$M/(HV+.1\alpha HS)$		$MS_{-1}/(HV+.1\alpha HS)_{-1}$							
HUANG	M				$\Delta MS/A$		H	LVR / AMORT						
JAFFEE (MPS)	r_m	r_{m-1}	r_{mm}		$(\Delta MS+\lambda MS_{-1})/(HV+HS)$									$(OCSL_{-1}+OCSB_{-1}+OCLI_{-1})/(HV+HS)$
KEARL-ROSEN	M	$(r_m-r_{mm})_{-1}$					H							
SILBER	ΔMS	Δr_m			ΔMS_{-1}					ΔY^P			ΔHHI	
CASSIDY-VALENTINE	r_m	$\frac{1}{4}[1r_m-r_{m-1}1+(r_m-r_{m-1})]$			MS		HS_{-1}			Y^P				

GLOSSARY

A	Total financial assets
AMONT	Amortization period
C	Construction costs
D_	Deposits in various thrift institutions
DUM_	Dummy variables
FHLB	FHLB advances
FNMA	FNMA mortgage acquisitions
H	Housing starts
HHF	Household formation
HS	Stock of housing
LVR	Loan value ratio
M	Mortgage flows
P	Price of other goods
PH	Price of housing
PI	Price, Housing investment
PI^e	Expected inflation rate of housing prices
POP_	Population variable
R	Rent index
r_{AAA}	AAA bond rate
r_{CP}	Commercial paper rate
r_M	Mortgage interest rate
r_{TB}	Treasury bill rate
SAV	Saving flows
STRG	Monetary stringency variable
SUB	Subsidized starts
S/P, B/P	Monetary base
T	Time
U	Unemployment
VAC	Vacancy rates
W	Wage
WL	Wealth
Y^D	Disposable income
Y^P	Permanent income

Superscripts:

D	Demand
S	Supply
VA, FHA, C	Mortgage types

Subscripts:

-i, ith	Lagged value
m, aaa, cp, etc.	Interest rate type

BIBLIOGRAPHY

1. Alberts,W.W. "Business Cycles, Residential Construction Cycles, and The Mortgage Market," Journal of Political Economy, 1962 pp. 263-281

Housing cycles are not due to fixed rates on FHA VA mortgages, but primarily because of other factors which change the supply of mortgage funds.

As aggregate demand in the economy falls, housing demand falls little, and permanent income may not have changed much. Therefore, housing demand has changed little relative to changes in the supply of mortgage funds. The supply of mortgage funds shifts because of changes in the relative yields of bonds and mortgages over the business and construction cycle.

No reported estimations.

2. Arcelus, F. and A.H. Meltzer, "The Markets for Housing and Housing Services," Journal of Money, Credit and Banking, 1973, pp.78-99.

A flow of services is generated from a given fixed stock. Demand for the services determines the rental price per unit of services. The supply of additions to the stock is determined by builders comparing the prices of new units with costs. Arcelus-Meltzer then assume a separate demand for new units as a function of the price of those units, income, wealth, interest rates, equity, rental rates and the expected expenditures for services generated by the stock relationship. A log linear annual model is estimated over the 1915 40, 1948-68 period.

Estimations indicate that the demand for services is significantly affected by the rental price, real income, prices and the real value of assets. The authors use the real mortgage stock and changes in the stock as measures of the importance of credit availability and loan-to-value ratios in housing demand. They find a high interest elasticity but no evidence that mortgage availability is important.

The authors conclude there is no relationship between the stock or flow of mortgage credit and the demand for housing. The interest rate not the composition of credit is important.

3. Atkinson, L.J., "Long-term Influences Affecting the Volume of New Housing Units," Survey of Current Business, 1963:11, pp. 8-19

Extensive treatment of the relationship between general demographic characteristics of the nation and household formation. The author, very much in the spirit of Maisel's work, links household formations to housing starts.

4. Atkinson, L.J., "Factors in the Housing Market," Survey of Current Business, 1960:4, pp. 16-22.

Article examines demographic, income and short-run financial impacts on housing.

5. Bosworth, B. and J.S. Duesenberry, "A Flow of Funds Model and Its Implications," Issues in Federal Debt Management, Boston, MA: Federal Reserve Bank of Boston, 1973, pp. 39-149.

The long run demand for mortgage funds is assumed dependent upon the demand for the underlying capital, housing units, and by portfolio choices. New building contributes to mortgage demand directly and indirectly through its effect on refinancing of old units. It is argued that most of the fluctuation in home building result from fluctuations in the supply of mortgage funds. Since builders expand activities when vacancies are low and contract when vacancies are high, vacancies serve as a measure of short run demand for mortgages. A disequilibrium model is proposed where lenders adjust rates but not enough to clear the market, this change also affected by competing yields and savings flows. Lenders lend consistent with their supply curve.

The model specifies an equation for the percentage change in the stock of mortgages which is assumed to depend on vacancy rates, mortgage and other market interest rates and a time trend. The equation is not estimated directly but is substituted into an equation representing the adjustment of mortgage rates.

The residential construction function simply translates changes in the mortgage stock to expenditures.

Changes in the real mortgage stock, changes in household formation, changes in the spread between mortgage and corporate bond rates, and a trend are found to be important determinants of residential construction.

6. Brady, E.A., "An Econometric Analysis of the U.S. Residential Housing Market," in National Housing Models, R.B. Ricks, ed., Lexington, MA: Lexington Books, 1973.

7. Brady, E.A., "A Sectoral Econometric Study of the Post-War Residential-Housing Market," Journal of Political Economy, 1967, pp. 147-158.

8. Brady, E.A., "A Sectoral Econometric Study of the Post-War Residential-Housing Market: Reply," Journal of Political Economy, 1970, pp. 274-278.

Brady discussed an underlying structural model but no rigorous derivation of estimated reduced forms is presented. Reduced form estimation of housing starts functions disaggregated by type of financing, FHA, VA, or conventional are examined. Variables are selected for the various functions by explorations leading to the best fit.

In the 1967 work, he hypothesizes that fixed interest ceilings on FHA and VA instruments have contributed to housing cycles. Estimation over the 1952-1963 period by OLS finds loan-to-value ratios, amortization period length, FNMA acquisitions, a trend and a measure of monetary stringence important determinant of starts.

Brady argues that government and conventional financed sectors of the housing market behave differently due to rigidity of government insured mortgage rates.

The 1971 work, a variety of dependent variables are regressed on the same variables as the 1967 work with the addition of construction costs and FHLB advances. The cost variable has the wrong sign, however.

Brady finds interest elasticities in the 1.0 to 2.8 range and loan-to-value elasticities from 2.5 to 4.6. FHLB advances are also important. He argues that conventionally financed and federally guaranteed or insured markets differ a good deal, and conclude that the major short run determinants of cycles are from the supply side of the market.

9. Brookings Quarterly Econometric Model of the United States

See S. J. Maisel

10. Burns, Arthur F., "Long Cycles in Residential Construction," in Business Fluctuations, Growth, and Economic Stabilization, Clark and Cohen (eds.), 1963.

Long cycles derive from the variability of population, durability of dwelling, and immobility of dwellings and men.

"Cyclical fluctuations shake out the inefficient so actually may benefit construction industry."

An interesting qualitative article speculating on the causes of the long cycle in construction.

No mention made of impact of financial variables on long cycles of construction.

11. Campbell, B.O., "Long Swings in Residential Construction: The Post-War Experience," AER Papers and Proceedings, 1963.

Long swings are essentially demographic in nature, size and age composition of population are crucial. Mentions impact of federal mortgage insurance programs in contribution to upward shift in single family demand during the post-war period. Explains discrepancy between starts and household formation on varying headship rates.

No model, or equations, concerned with non-financial determinants of demand. Ignores financial factors when attempting to explain deviation from expected starts from household formations.

12. Cassidy, H.J. and J. Valentini, "A Quarterly Econometric Model of the U.S. Housing, Mortgage, and Deposit Markets," unpublished paper presented at the 1972 Winter Meetings of the American Real Estate and Urban Economics Association.

Households demand for housing services is determined by the implicit rental (which differs for owner-occupied and rental units and influences the rent-buy decision) and permanent income. Comparing this demand with the stock of housing determines vacancies. The authors postulate a demand for new units based on the excess demand for the stock, mortgage interest rate and change in mortgage rate. Supply of starts, normalized on prices, is determined by unemployment, wage rate and prices in the construction industry.

The Cassidy-Valentini model emphasizes a stock demand for mortgages. The demand for the stock of mortgages depends on the mortgage rate, the nominal value of the housing stock and permanent income. The equation is estimated by normalizing on the mortgage rate and allowing for possible disequilibrium by including positive changes in the mortgage rate.

13. Clauretie, T.M., "Interest Rates, the Business Demand for Funds, and the Residential Mortgage Market: A Sectoral Econometric Study," Journal of Finance, December 1973, pp. 1313-1326.

Claurette attempts to test the degree to which business demand for funds affect the supply of mortgages in ways not wholely reflected by the interest rate.

Claurette presents a mortgage market model where the demand for mortgages is assumed to depend on permanent income, the ratio of rent to home ownership costs, the loan-to-value ratio, the average maturity of mortgage contracts, the number of people aged 25-34 and the mortgage rate. Numerous regressions are run with both net and gross changes in mortgages as the dependent variable. The maturity measure and loan-to-value rate always have a positive impact on the demand for mortgage.

14. Data Resources Model

The DRI model specifies the demand for mortgages in terms of an equation for the mortgage rate. Variables entering the equation include current and lagged corporate bond yields, the percentage change in FNMA plus GNMA mortgage holdings, a weighted average of deposit rates at savings and loan associations and mutual savings banks, and two variables that are the ratio of mortgage acquisitions and the stock of mortgages to residential construction plus a measure of capital gains on the existing stock.

The DRI model is estimated on quarterly data availability for the particular function. A starts equation is estimated, which essentially links starts plus mobile homes to real mortgage flows, real interest rates, and vacancy rates. Relationships, vacancy rates, mobile home shipments, implicit price deflator, mortgage yield and mortgage flows are also estimated.

The stock is an important determinant of vacancy rates along with household assets, population and unemployment rates. The price equation depends upon variables outside of the housing sector: employee compensation, price of gross product, and a production index. The mortgage rate is functionally related to bond yields, housing stocks, consumption expenditures on housing and mobile homes, mortgage acquisitions and thrift institution deposit rates.

FNMA and GNMA acquisitions enter the mortgage yield equation separately from mortgage acquisitions by other financial intermediaries.

No price or cost variable appear in the starts function.

15. Dhrymes, PJ and Taubman, PJ, "An Empirical Analysis of the Savings and Loan Industry" in I Friend, ed., Study of the Savings and Loan Industry, Washignton, DC: Federal Home Loan Bank Board, 1969, pp. 67-182.

Dhrymes and Taubman use data from a time series of cross sections of S&L's for 1964-1966. Their data is then aggregated to SMSA averages. They relate the demand for all new mortgages at S&L's to normal income per capita, the amount of building activity is measured by the value of permits, the mortgage rate, the loan to value ratio, the lagged stock of mortgages and the amount of repayments. Equations are estimated for western (California) and non-western associations and including and excluding 1966. Dhrymes and Taubman consider the results for western associations unreliable. Results for non-western associations appear to be quite sensitive to the inclusion or exclusion of 1966 as well as the use of a generalized least squares procedure designed to reduce some cross section biases.

16. Duesenberry, JS and Kistin, H, "The Role of Demand in Economic Structure," in W. Leontief et al, Studies in the Structure of the American Economy, NY Oxford U. Press, 1953.

The authors found an extremely low (.078) demand elasticity with respect to price, real income constant.

17. deLeeuw, F. "The Demand for Housing: A Review of Cross-Section Experience," Review of Economics and Statistics, 1971

Reviews the work of Muth, Reid, Lee and Winger, and concludes that the income elasticity is between .8 - 1.0. It tends to be higher for owner occupied than for rental housing, lower for non-whites and increases with household size.

Using data from the 1960 Census, deLeeuw estimates renter income elasticities between .8 and 1.0 and relative price elasticities for renters in the .7 - 1.5 range.

18. deLeeuw, F. and N. Ekanem, "Income and the Cost of Rental Housing," Working Paper 112:11, Urban Institute 1970.

Using data from a 1967 cross section and imposing demand elasticities from earlier studies, the authors find elasticities of supply with respect to per unit service (rental) between .3 - .7, with respect to cost of capital inputs between -.5 to -.2, with respect to operating inputs in the -.3 to -.1, range and with respect to the number of households about 1.0.

19. deLeeuw, F. and N. Ekanem "Time Lags in the Rental Housing Market," Working Paper 112:19, Urban Institute 1970.

Using demand and supply elasticities from earlier studies, this study investigates the dynamics of adjustment of the rental market. The authors conclude that the annual speed of adjustment for demand response to income and price change is .25, for rent response to utilization of stock is .40, for rent response to costs is .10, and the supply response to profitability is, with some uncertainty, in the .30 region.

20. deLeeuw, F. and E.M. Gramlich, "The Channels of Monetary Policy," Federal Reserve Bulletin, June 1969, pp. 472-491

MPS Model, see J.H. Kalchbrenner.

21. Evans, M.K. Macroeconomic Activity, New York: Harper & Row, Publishers, 1969.

Quarterly model using value of residential investment is estimated. Evans argues that a good measure of credit tightness is the spread between short term and long term rates. The principal determinant of long run housing demand is household formation. Income is not viewed as an important long run determinant nor are credit conditions, but these variables do affect short run behavior: income affecting the value per start, interest spreads as a measure of the residual nature of housing finance. Cycles are primarily a supply phenomenon, resulting from the residual credit and labor that is available to builders.

22. Fair, R.C. "Disequilibrium in Housing Models", Journal of Finance, 1972, pp.207-221.

23. Fair, R.C. "Monthly Housing Starts", in National Housing Models, R.B. Ricks, ed., Lexington, Mass: Lexington Books, 1973, pp.69-84.

24. Fair, R.C. A Short-run Forecasting Model of the United States, Chapter 8, Lexington, Mass: Lexington Books.

Fair develops a monthly structural model of housing starts. Only looks at the market for new houses and mortgages. Uses a disequilibrium model in the sense that either on the demand or supply (of funds) schedule, where the direction of interest rate movements indicates which. Assumes that changes in the loan value ratio are reflected by a secular trend (i.e. no cyclical fluctuations). Theoretically specifies three sectors, demand for mortgages (and asssumes is equivalent to demand for new houses), supply of mortgage funds, and supply of houses by builders. In estimation eliminates the latter.

The demand for housing starts is a function of time (population plus income), stock of houses and houses under construction, mortgage interest rate lagged two months, and seasonal factors. The supply of funds is a function of deposit flows into thrift institutions, advances of FHLB, seasonal factors, and the mortgage rate lagged one month.

The model is estimated on monthly data, from 1959:6 to 1969:11, using the 2SLS disequilibrium technique described by Fair and Jaffee (Econometrica, 1972).

25. Federal Reserve Staff Study: Ways to Moderate Fluctuations in Housing Construction; Board of Governors of Federal Reserve System, December 1972

26. Flow of Funds Model (See Bosworth and Duesenberry)

27. Friend, I., Study of Savings and Loan Industry, FHLBB, Washington, July 1969, 4 volumes

27a. Fromm, G., "Econometric Models of the Residential Construction Sector: A Comparison," National Housing Models, B. Ricks (ed.), (Lexington Books, Lexington, Mass., 1973)

28. Geisel, M., "A Survey of Time Series and Cross-Section Studies of Housing," unpublished paper, Carnegie-Mellon University, 1971.

Geisel suggests, in support of deLeeuw, that income elasticity is approximately one.

29. Grebler, Leo, "Housing Issues in Economic Stabilization," NBER Occasional Paper, 72, 1960.

"Given long-run demand and supply forces favorable to residential building, short run cycles in housing construction were associated for the most part with changes in the supply of mortgage funds and credit terms, which in turn were greatly influenced by the level of total economic activity. When that level was rising and high, the expanded demand for funds by business, which is relatively insensitive to increased cost of borrowing tended to reduce the availability of funds for housing, which is highly sensitive to changes in cost of borrowing."

FHA-VA fixed rates contribute to housing cycles.

30. Grebler, Leo, "Stabilizing Residential Construction - A Review of the Postwar Test," American Economic Review, 1949.

Emphasizes role of liberalized credit terms, downpayment, interest rates, and amortization period in creating housing boom.

Mentions that effects of liberal credit stimulating demand may lead to price increases which wipe out much of the expected gain from liberal credit.

The post-war period saw large price increases.

31. Grebler, L. and S. Maisel. "Determinants of Residential Construction: A Review of Present Knowledge." Impacts of Monetary Policy, Commission on Money and Credit, (Prentice-Hall, Englewood Cliffs, N.J.), 1963

32. Grebler, L., Blank, D.M., Winnick, L. Capital Formation in Residential Real Estate (Princeton U. Press, 1956).

Found a marked retardation in the rate of growth of residential construction and in the real capital investment per new dwelling unit despite changing financial positions and increasing real income over the 1890-1950 period. Claimed to show a 15% decline in the average value of a unit of stock, a 36% decline in the average values of new units while the stock climbed only 7% in value.

33. Guttentag, J. "The Short Cycle in Residential Construction, 1946-59." American Economic Review, 1961, pp. 275-298.

Emphasizes the central role of mortgage credit in the short cycle in residential construction. This qualitative analysis examines the relations between construction and mortgage yields, mortgage terms and Federal influences in the market.

Since other demand factors do not change much in the short run, i.e. income, demographic, and relative prices, availability and price of credit is perceived as crucial in explaining short run cycles.

He argues "the volume of mortgage credit is a sort of residual, in that home buyers can obtain only that volume of credit which remains after more volatile and persistent demands of corporations have been satisfied." He also suggests that the importance of FHA-VA ceilings in determining mortgage flow have been over emphasized. Finally he suggests that FNMA has tended to mitigate cycles due to its sticky mortgage purchase prices.

34. Housing and Monetary Policy Conference Series No. 4, The Federal Reserve Bank of Boston, October 1970.

35. Huang, D.S. "Effects of Different Credit Policies on Housing Demand," Study of the Savings and Loan Industry, Vol. III, I. Friend, ed., Washington: Federal Home Loan Bank Board, 1969.

Develops a supply-demand structural model of both the mortgage and housing markets. Disaggregates by three sectors: FHA, VA, and conventional sector. "It is well recognized in the financial market that the supply of mortgage credit has a controlling influence over housing starts, and it may be said that the direction of causation here is generally accepted as from mortgage credit supply to housing starts."

Estimates demand and supply for starts in terms of units and dollar value for the three sectors. Also estimates the demand for and supply of mortgage funds.

He estimates his model by OLS on quarterly data from 1953:2 to 1965:4. A number of financial variables, such as interest rates, loan-to-value ratio, interest rate ceilings, and savings flows are used, although he selects the actual variable in each function by experimentation.

Huang finds that loan-to-value ratios are consistently important determinants of flow demand of new housing units. Average maturity lengths were not found significant nor percentage of loan paid per year except for VA guaranteed homes. Mortgage interest rates were found to be not significant but household formation and a debt term were significant.

FNMA and FHLB were important in appropriate supply functions and yields and yield spreads are predominant in influencing mortgage flows.

The demand for mortgages (gross borrowings) is assumed to derive from the value of housing starts, the change in the ratio of mortgage debt to total financial assets and the "proportion of mortgage loans payable per annum" (loan-to-value ratio divided by the maturity).

Equations are estimated by the type of mortgage - FHA, VA, conventional. The value of starts has a positive effect while the ratio of mortgage debt to financial assets and the proportion variable both have negative effects.

35a. Huang, D.S., "A Study of the Market for New Housing Units," Proceedings: Business and Economic Section, American Statistical Association, 1969.

36. Huang, D.S., "The Short-Run Flows of Non-farm Residential Mortgage Credit," Econometrica, 34, (April 1966), pp. 433-459.

Huang concentrates on mortgages for single-family units. The model related the demand for mortgages to the desired level of owner-occupied housing - represented by income and the ratio of rents to construction costs - the nominal mortgage rate and the change in the amortization period. The change in the amortization period is assumed to reflect non-interest rate credit terms and to correct the measure of the mortgage rate which is a measure of mortgage yield assuming fixed maturity and prepayment. The change in the amortization period is estimated to have a psoitive impact on the demand for mortgages.

37. Huang, D.S. and M.D. McCarthy, "Simulation of the Home Mortgage Market in the Late Sixties," Review of Economics and Statistics, 69 (November 1967), pp. 441-450.

Simulations with a model very similar to Huang's "Short Run Flows" model; demand for mortgages are now disaggregated by type of financing - conventional, FHA, VA.

38. Jaffee, D.M., "An Econometric Model of the Mortgage Market: Estimation and Simulation," Chapter 5, in Savings Deposits, Mortgages and Residential Construction, Gramlich and Jaffee (eds), Lexington: Heath-Lexington, 1972.

The demand for the stock mortgages is assumed to depend on the value of the housing stock, the mortgage rate and a corporate bond rate as a single proxy for other market rates. Jaffee notes that mortgage funds may be used for other purposes than purchasing a house. He also notes that other non-rate terms of the contract should, in principle, affect the demand for mortgages. Differential time responses are allowed for the mortgage demand arising from new construction and the existing stock. Jaffee's equation is estimated implicitly following substitution into a mortgage rate adjustment equation.

39. Kalchbrenner, J.H. "A Model of the Housing Sector," in Savings Deposits, Mortgages and Housing, E.M. Gramlich and D.M. Jaffee, eds. Lexington, Mass: Lexington Books, 1972.

40. Kalchbrenner, J.H. "A Summary of the Current Financial Intermediary, Mortgage and Housing Sectors of the FRB-MIT-Penn Econometric Model," in National Housing Models, R.B. Ricks, ed. Lexington, Mass: Lexington Books, 1973.

41. Kalchbrenner, J.H. "Theoretical and Empirical Specifications of the Housing Sector," in Ways to Moderate Fluctuations in Housing Construction, Washington: Federal Reserve Board of Governors, 1972.

The supply of housing services is assumed proportional to the housing stock. Given the stock, the demand forhousing services, a function of permanent income and relative prices determines an implicit rental. This rental,together with a housing cost of capital, determines the asset prices of the stock. Builders compare their costs with the asset price and this yields additions to the stock in the form of residential investment. This addition to the stock drives down the asset price and consequently net investment falls. In equilibrium, the housing stock, the housing price, the cost of capital and construction costs adjust to steady-state values.

Given the stock, the demand for services function is rewritten in terms of the implicit rental. Since, in equilibrium, this rental relative to the price of the stock equals the cost of capital, the rental can be eliminated by substitution. An empirically workable reduced form is obtained by substituting for the asset price of the stock the appropriate relationship from the supply side.

The model is estimated quarterly from 1954:4 to 1969:3 in log linear form by OLS. Separate functions are estimated for single family plus mobile homes and multifamily, basically as outlined above except for the addition of variable to account for rationing in the mortgage market. The permanent income elasticity is constructed to unity.

The model also estimates relationships for total housing expenditures and the stock. The cost of capital relationship for single family units is created by assumption about depreciation and opportunity costs. No cost of capital appears in the multifamily relationship.

The cost of capital is used only in the single family function and failed to have approrpiate sign in the multifamily function as it has been omitted from that specification. Rationing is handled in a rather ad hoc manner.

42. Kalchbrenner, J.H., "A Summary of the Current Financial Intermediary, Mortgage and Housing Sectors of the FRB-MIT-Penn Econometric Model," in National Housing Models, R.B. Ricks (ed), Lexington: Lexington Books, 1973

(See D.M. Jaffee).

43. Kearl, J.R. and K.T. Rosen. "A Model of Housing Starts, Mortgage Flows, and the Behavior of the Federal Home Loan Bank Board and the Federal National Mortgage Association," Working Paper #27, Joint Center for Urban Studies, May 1974.

A six equation quarterly simultaneous model is specified and estimated: demand and supply for starts, demand and supply of mortgages and reaction functions for FHLBB and FNMA.

Demand for starts is found to be strongly related to the relative price of housing, mortgage interest rates, the loan-to-value ratio, and subsidies. Supply of starts is determined by vacancy rates, prices, construction loan rates and mortgage commitments.

The demand for mortgages depends on housing starts and the spread between the mortgage rate and the corporate bond rate.

The authors use three stage least squares over the 1962:4-1972:4 time period.

The research is primarily concerned with the structure of FNMA and FHLBB and their interactions with the mortgage and housing markets. Both FNMA and FHLBB are found to have strong positive impacts on mortgage flows even though they do not always behave in an appropriate counter-cyclical manner.

44. Klaman, S.B., "Effects of Credit and Monetary Policy on Real Estate Markets," Journal of Land Economics, August 1956, pp. 239-249.

45. Klaman, S.B., "The availability of Residential Mortgage Credit," in Committee on Banking Currency, Subcommittee on Housing, U.S. Senate, Study of Mortgage Credit, Washington, GPO, 1958.

Interest ceilings on FHA and VA mortgages have intensified the impacts of monetary policy on the housing sector, and are the primary cause of housing cycles.

46. Klaman, S., The Post War Residential Mortgage Market, Princeton University Press, 1961

47. Klein, L.R. "A Postwar Quarterly Model: Description and Applications," Studies in Income and Wealth, 1964.

48. Lee, T.H. "The Stock Demand Elasticities of Non-Farm Housing," Review of Economics and Statistics, 1964, pp. 82-89.

Annual model of housing, 1920-41, using OLS on value of construction per family. Lee argues that Muth's income elasticity is biased upward by omission of credit terms. Concludes that income elasticity less than unity, price elasticity exceeds unity and demand is strongly related to mortgage costs and down payments.

Price elasticity is near one (-1.07) but the income elasticity is quite low (.336). Elasticities for loan-to-value variables (.865) and interest times mortgage length (-.277) are estimated.

49. Lee, T.H. "Demand for Housing: A Cross Section Analysis," Review of Economics and Statistics, 1965, pp. 190-196.

Cross section probability study. Concludes that current income does not appear important determinant of probability of buying a home. However, age is an important factor in accounting for price and probability of incurring mortgage debt.

50. Liu, T.C. "An Exploratory Quarterly Econometric Model of Effective Demand in the Postwar U.S. Economy," Econometrica, 1963, pp.301-48.

A quarterly model is estimated over the 1947:3-1959:4 period. Both OLS and TSLS techniques are used, although simulations are conducted with the OLS estimates. Housing investment is modeled within a very simple investment structure, and is functionally related to corporate bench rates and money supply variables.

51. Maisel, S.J. "The Effects of Monetary Policy on Expenditures in Specific Sectors of the Economy," Journal of Political Economy, 1968, pp.796-814.

52. Maisel, S.J. "Non-business Construction," in The Brookings Quarterly Econometric Model of the United States, J.S. Duesenberry et al, eds., Chicago: Rand McNally & Co., 1965.

53. Maisel, S.J. "A Theory of Fluctuations in Residential Construction Starts," American Economic Review, 1963, pp.359-383.

Maisel views cyclical behavior in housing as analogous to inventory cycles. There is an underlying demand, a function of household formation and removals from the housing stock, which form a relatively stable equilibrium. Forces imbedded in the construction process create fluctuations in vacancies and inventories which cause cycles in starts around the underlying basic demand equilibrium. Starts are influenced by credit through inventories and vacancies rather than through final demand or through changes in household formation.

A quarterly model is estimated over the 1950-60 time period by OLS. Later articles extend the estimation period to 1962, then from 1953:2-1967:2. In the Brookings work functions for household formation expenditures and average cost per unit are estimated. Relationships are postulated for removals and vacancy deviations.

In the most recent article,Maisel includes in five separate regressions credit variables including mortgage interest rates, savings flows and FNMA purchases. He concludes that, at the the interest elasticity is .56 and credit availability elasticity is .07.

54. Maisel, S., Burnham, J and Austin, "The Demand for Housing: Comment," Review of Economics and Statistics, 1971.

Using data on a cross section, the authors found that grouping observations biased the income elasticity upward by 50%. They argue that the elasticity is consequently closer to .62 (near Less's .7) than 1.0.

55. Mattila, J.M. "An Econometric Analysis of Construction," Wisconsin Commerce Reports, April 1955.

A study of the value of starts from 1920-41. Found that a composite credit term, mortgage interest divided by the product of the loan-to-value ratio and the amortization period was not a significant determinant of the housing demand.

56. McCarthy, M.D. The Wharton Quarterly Econometric Forecasting Model, Mark III, Studies in Quantitive Economics No. 6, Wharton School of Finance and Commerce, 1972.

The present model follows very much M.D. Evans approach to modeling housing. A value of residential investment is estimated. The sector is completed by estimated relationships of depreciation and price deflator for residential investment and definitional relationships.

57. McElhone, J.M. and H.J. Cassidy, "A Call for Innovation," Federal Home Loan Bank Board Journal, July 1974.

58. Meltzer, A.H. "Credit Availability and Economic Decisions: Some Evidence from the Mortgage and Housing Market," Journal of Finance, June 1974, pp.

Long term data show that housing stocks have grown at approximately the same rate as other assets and much less than mortgage credit. The ratio of housing to total assets remained unchanged over a period in which the availability of mortgage credit rose rapidly. Meltzer argues that there is no empirical evidence that availability of mortgage funds matters in the housing market.

59. Modigliani, F.M., "Some Economic Implications of the Indexing of Financial Assets with Special Reference to Mortgages," Sloan School Working Paper #736-74, MIT, September 1974

60. MPS Model

(See J.H. Kalchbrenner)

61. Muth, R.F. "The Demand for Non-farm Housing," in The Demand for Durable Goods, A.C. Harberger, ed., Chicago: The U. of Chicago Press, 1960.

62. Reid, M.G. "Capital Formation in Residential Real Estate," Journal of Political Economy, 1958, pp. 131-153.

In a review of Grebler, Blank, Winnick, Capital Formation....., Reid argues that there has been an upward trend in quality and over the period, 1920-1929. She found high high elasticities of both income (1.78-2.30) and price (.91-2.45). In a 1950 section respective elasticities are estimated to be 2.03 and 1.61.

63. Schaef, A., "Federal Mortgage Interest Rate Policy and the Supply of FHA and VA Credit," Review of Economics and Statistics, November 1958 pp. 284-289.

Housing cycles result primarily from the structure of fixed rates.

64. Silber, W.L., "An Econometric Model of the Mortgage Market," in Cyclical and Growth Problems Facing the Savings and Loan Industry, A.W. Sametz (ed.) Bulletin No. 46-47, Institute of Finance, N.Y.U., 1968.

The demand for the stock of mortgages is related conceptually to the desired stock of houses, the nominal mortgage rate, the loan to value ratio and the amortization period. All variables, including the determinants of the desired stock of houses, are assumed to enter linearly. The final estimated equation drops all variables except income and the mortgage rate. The lagged mortgage stock is also included to represent a stock adjustment mechanism.

65. Silber, W.L., Portfolio Behavior of Financial Institutions, New York: Holt, Rinehart and Winston, 1970.

There is an elaborate discussion and estimation of the demand for mortgages by financial institutions. There is no discussion or estimation of the demand for mortgage credit (supply of mortgage liabilities).

66. Smith, L.B. "A Bi-Sectoral Housing Market Model," Canadian Journal of Economics, 1969, pp.557-569.

67. Smith, L.B. "A Model of the Canadian Housing and Mortgage Markets," Journal of Political Economy, 1969, pp.795-816.

68. Smith, L.B. Housing and Mortgage Markets in Canada, Bank of Canada, 1970.

Develops a model of the Canadian housing and mortgage market, which specifically recognizes both the segmentation and linkages between the two markets within a stock flow framework.

States that "credit variables have a strong influence on the demand for housing, since, for most families this demand is quite sensitive to downpayment and monthly payment requirements; and these payments depend upon the nominal purchase price, the mortgage interest rate, the loan-to-value ratio and the amortization term of the mortgage." He believes that credit terms have a stronger impact on the quality of housing services demanded, than on number of units demanded.

EStimates reduced form equations for investment in residential construction, total housing starts, price of housing, total stock of housing units, construction costs, land costs, and conventional mortgagemortgage interest rates. He uses both OLS and 2SLS techniques on quarterly data for the period from 1954-1967.

The two credit variables, mortgage interest rate, and a variable to proxy availability of mortgage funds (spread between the mortgage interest rate and other market rates), are significant and have the correct sign. He finds an interest elasticity for SF starts of -1.56.

69. Smith, L.B. "A Sectoral Econometric Study of the Postwar Residential Housing Market: An Opposite View," Journal of Political Economy, 1970, pp.268-273.

Smith examines two models: a Muth-type long run stock demand for housing and a short run supply model. Using these models and Canadian data, he suggests that the dramatically different behavior of conventional and government backed mortgaged housing starts found by Brady is not supported with his data. Smith argues that the two sectors do respond to the same economic variables and in similar ways.

He estimates starts equations with and without lagged stock. Both models show strong relationships between starts and interest rates and mortgage flows.

70. Smith, W.L. Staff Report on Employment, Growth and Price Levels, Joint Economic Committee, Washington: GPA, 1958.

71. Smith, W.L. "The Impact of Monetary Policy on Residential Construction, 1948-1958," in Committee on Banking and Currency Subcommittee on Housing, U.S. Senate, Study of Mortgage Credit, Washington: GPO, 1958.

72. Smith, W.L. Interest Rates and Their Economic Implications, Conference on Savings and Residential Financing, 1966.

Advances a fixed rate hypothesis: interest ceilings on FHA and VA mortgages have interfered with free market processes and have intensified the impact of monetary policy on the housing sector.

73. Sparks, G.R. "An Econometric Analysis of the Role of Financial Intermediaries in Postwar Residential Building Cycles," in Determinants of Investment Behavior, R. Ferber, ed., New York: NBER, 1967.

74. Sparks, G.R. "A Model of the Mortgage Market and Residential Construction Activity," American Statistical Association, Proceedings, 1967.

Sparks attempts "to combine Maisel's approach with a more detailed treatment of the supply of mortgage funds."

He develops a reduced form model of housing starts and flow of funds to financial intermediaries. His starts equations contains no credit terms but does include a mortgage supply term (actual loans and forward commitments). The start equation also includes a vacancy variable, a rent/cost ratio, household formation and income. The mortgage supply term in the start equation is derived from previously fitted equations on mortgage lending and commitment by financial intermediaries.

The demand for the flow of mortgage credit is assumed to depend on the same factors as housing starts. The demand for mortgage credit is never estimated directly. By substitution it is implicitly included in the equation for housing starts.

The model is estimated on annual data, from 1949-1964, by OLS.

The flow of funds to intermediaries is the major variable explaining mortgage lending and commitment.

Concludes that the supply of funds and household formations from the basis for explaining the cyclical behavior of housing.

75. Suits, D.B. "Forecasting and Analysis with an Econometric Model," American Economic Review, 1962, pp.104-32.

Starts equation is estimated over the 1947-1960 period, starts related to interest spreads. Expenditures equations estimated on lagged starts.

76. Swan, C. "A Quarterly Model of Housing Starts: A Disequilibrium Approach," Working Paper, 39, Federal Home Loan Bank Board, 1972.

77. Swan, C. "Housing Markets: An Aggregate View," Working Paper 40, Federal Home Loan Bank Board, 1972.

78. Swan, C. "Homebuilding: A Review of Experience," Brookings Papers on Economic Activity, 1970, pp.48-70.

79. Swan, C. "Housing Subsidies and Housing Starts," Federal Home Loan Bank Board, Working Paper 43, April 1973.

In the BPEA work, Swan proposes a simple reduced form starts equation, estimated on quarterly data over the 1958:1-1965:4 period. This model captures the 1966 housing trough but misses the 1969 one. Swan argues that the two experiences differ primarily due to changes

in a Maisel type basic demand. That is, the 1966 crunch was preceded by inventory accumulation and high vacancy rates, while household formation lead to a large shift in demand up to 1969, low vacancy rates and consequently an ameliorated impact. Differences in FHLB and FNMA actions may also have contributed to differences in the experience.

Develops a quarterly model of housing starts using Fair-Jaffee disequilibrium approach. Models demand and supply for starts, with actual starts determined by the smaller of the two. His dis-equilibrium variable is the mortgage interest rate which responds to excess demand or supply of housing starts.

Demand forhousing starts is a function of logged mortgage interest rate, lagged vacancy rate (defined as deviation from normal vacancy rate using actual occupancy rate figures), and time trend (replacement and household formation). The supply of starts is really a supply of mortgage credit equation. Supply is a function of lagged mortgage interest rate, lagged savings inflows and FHLBB advances to thrift institutions and a time trend (to deflate dollar volume of SFLOWS).

In the demand forstarts equation lagged mortgage interest rate and change in the mortgage interest rate have - sign, while in the supply equation mortgage interest variables and the flow of funds have a positive impact.

The model is quarterly, 1960:1 to 1970:4, estimated by OLS, with experiments on constraining the coefficient of mortgage interest rate.

Working Paper #40 presents simulation results of Swan's extension of Fair's model. Swan argues that FNMA is an important stabilizing influence in the mortgage market, although the model proxies FNMA only with time and interest variables. Subsidy programs and their possible linkages to the housing sector are discussed and preliminary simulations undertaken of their impacts.

FHLBB paper No. 43 expands the disequilibrium model first presented in working paper to include an explicit treatment of subsidized units. Subsidy programs are assumed to shift the demand for starts but not the financial supply curve. (The time trend in the demand function is replaced by the measure of the stock of houses derived from data on households and occupancies rate.) Swan's estimates imply a highly elastic demand function and highly inelastic supply function. As a result increases in the subsidized housing programs have little net impact on the total number of starts as increases in the mortgage rate eliminate non-subsidized units.

80. Swan, C. "The Markets for Housing and Housing Services," Journal of Money, Credit and Banking, 1973, pp.960-972.

Comment on Arcelus-Meltzer article. Swan argues that in the housing literature, there is no implication that changes in mortgage credit affect the demand for housing services but the impact is on the natural number of starts. Emphasis is placed on savings flows and mortgages because of the extensive use of mortgage credit to purchase housing units and because of non-price rationing in mortgage markets.

81. Thygerson, K.J., "The Effect of Government Housing and Mortgage Credit Programs on Savings and Loan Associations," Occasional Paper #6, U.S. Savings and Loan League, 1973.

82. Tucker, D.P., "The Variable-Rate Graduated-Payment Mortgage," unpublished paper, Board of Governors of the Federal Reserve System, January 1974.

83. Van de Water, P. "Property Tax Incidence in the MPS Econometric Model of the United States Economy,"unpublished Ph.D. Thesis, MIT, 1974.

Van de Water extends the present MPS structure (see Kalchbrenner) to include the combination of land and housing capital in the provision of housing services. Unlike the present reduced form estimation in the current model, Van de Water estimates supply and demand functions. He finds a high price elasticity of demand and significant credit rationing.

84. Wood, R. "Credit Terms and the Demand for Residential Construction," Study of Mortgage Credit, Committee on Banking and Currency, Subcommittee on Housing, 1958.

85. Wharton Model (See M.D. McCarthy and M.D. Evans).